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Fink et al.

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(54) **CONNECTOR POSITION ASSURANCE DEVICE**

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(73) Assignee: **Delphi Technologies, Inc.**, Troy, MI (US)

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(51) **Int. Cl.**[7] **H01R 13/627**; H01R 3/00; H01R 13/502

(52) **U.S. Cl.** **439/352**; 439/489; 439/701

(58) **Field of Search** 439/352, 157, 439/347, 752, 575, 701, 488, 489

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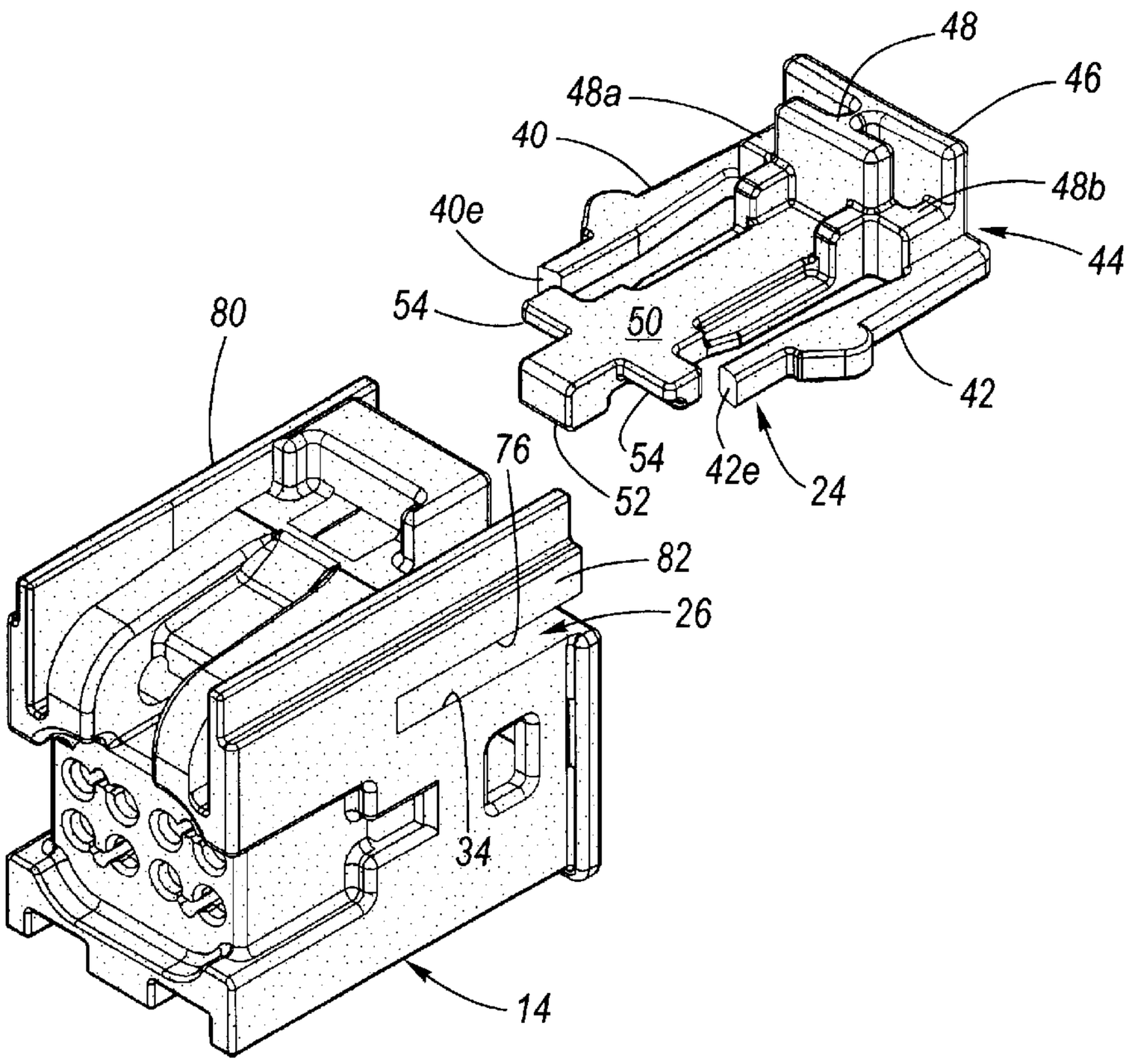
(57) **ABSTRACT**

A CPA device located entirely on a first connector of a pair of interfitting connectors, wherein the CPA device is actuable only in the event that the two connectors are actually mated. A slide slides between a prestaged position and a staged position. The latter position is attained only upon release of a CPA actuation lock which automatically occurs upon mating of the connectors. The slide is then slid to the staged position, whereat the slide interferes with a clasp mechanism of the connectors so as to prevent unintentional release of the clasp mechanism.

12 Claims, 5 Drawing Sheets



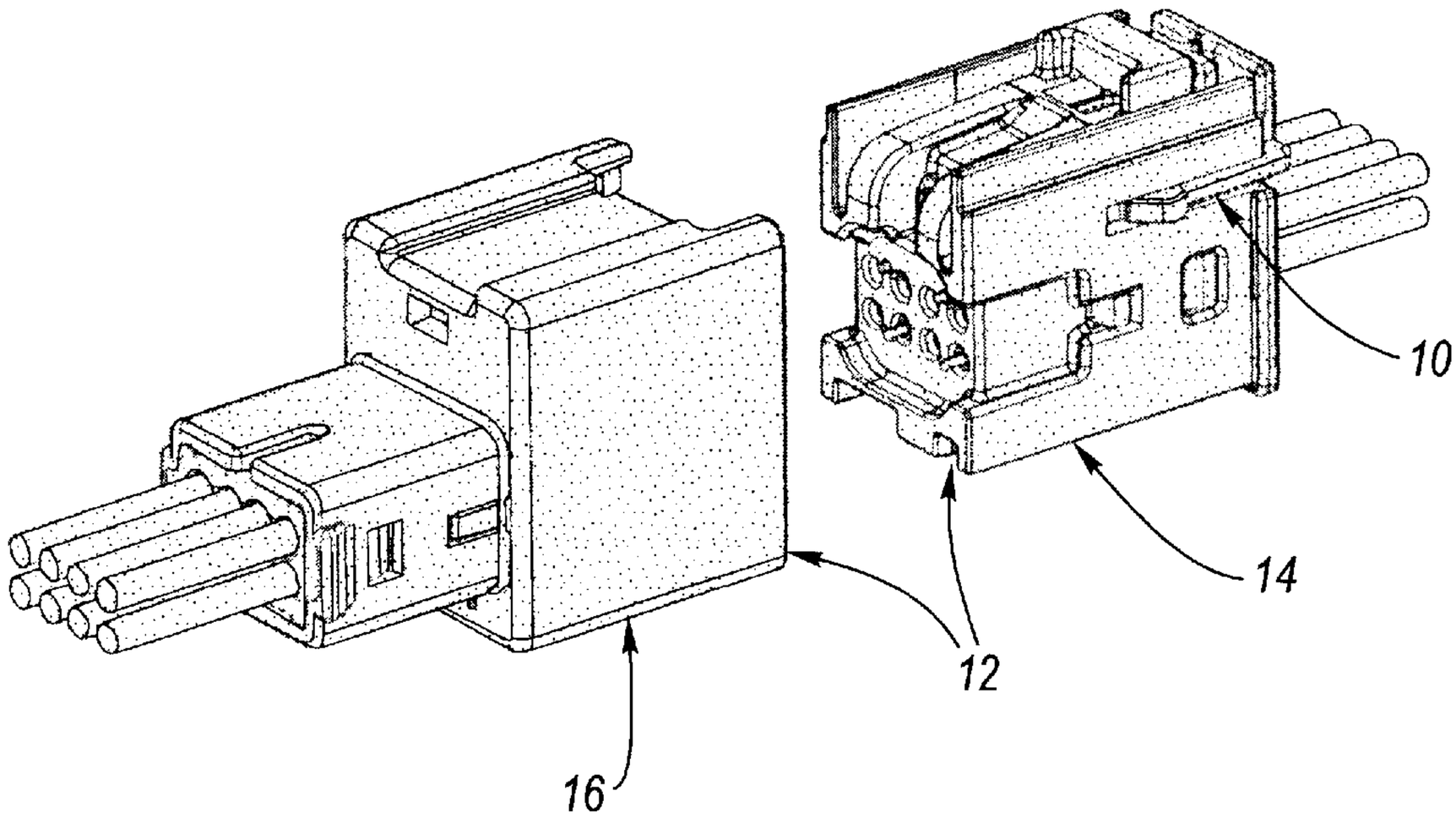


Fig. 1

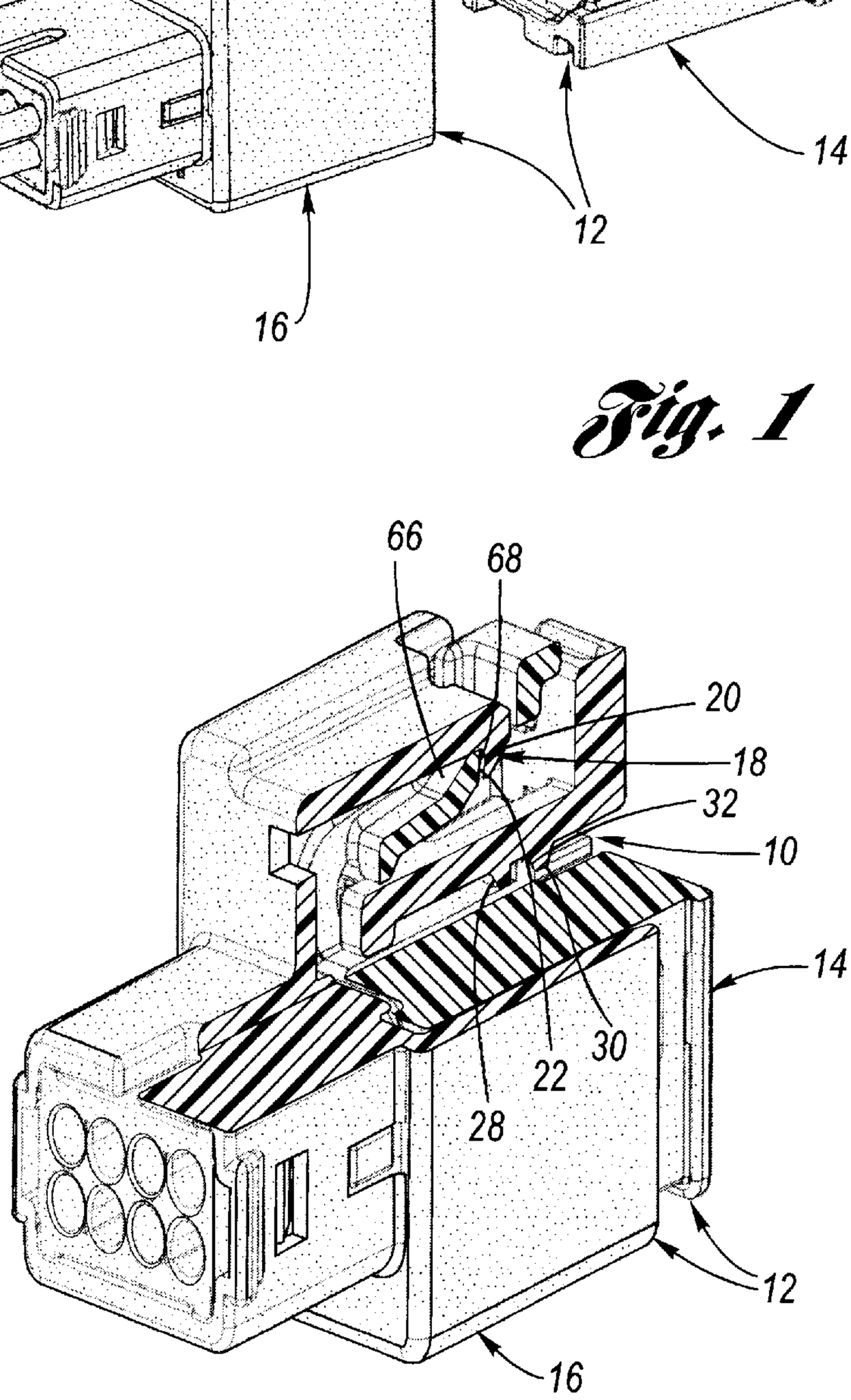


Fig. 2

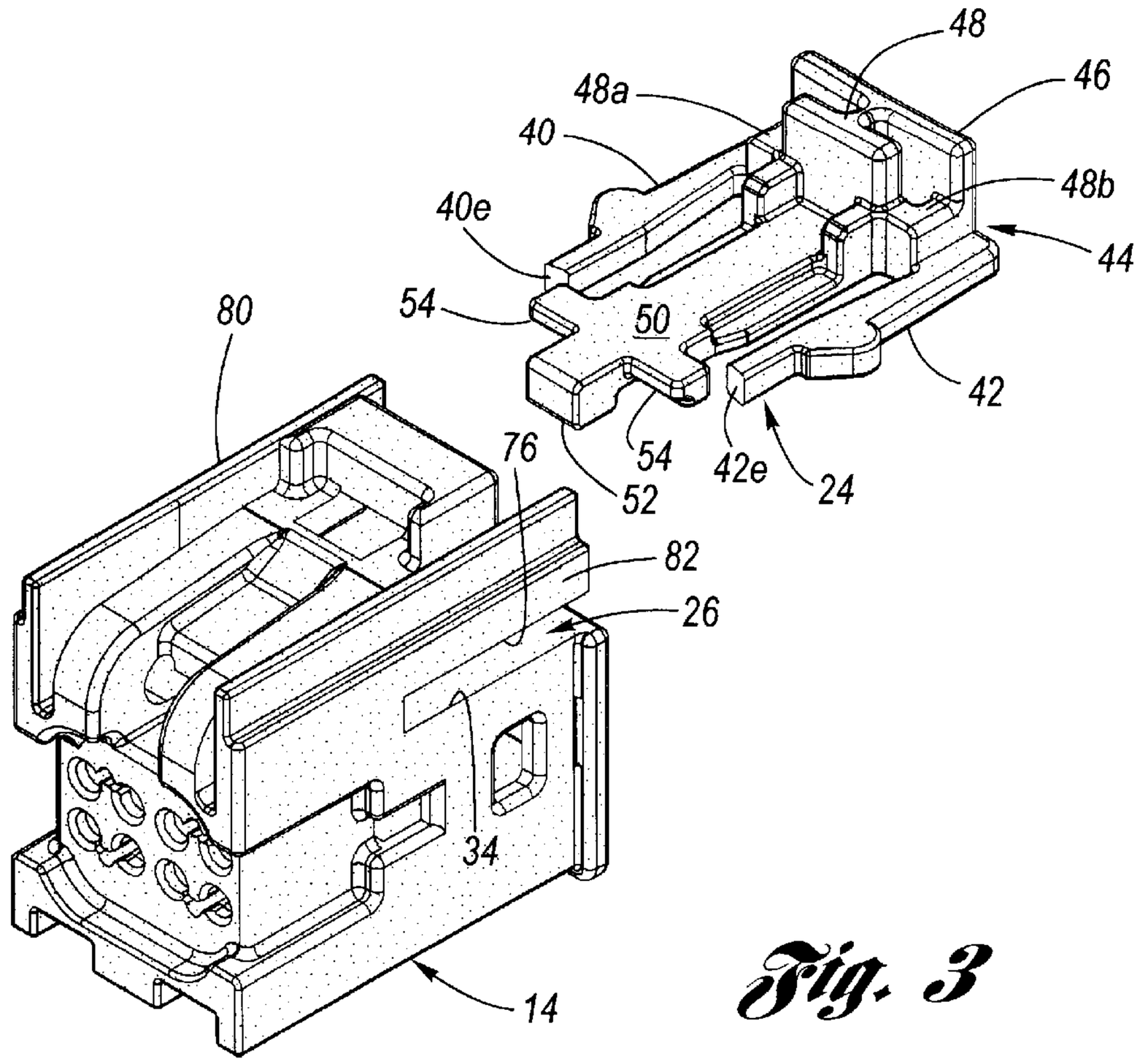

48
46
48a
40
48b
40e
44
54
50
80
42
76
54
42e
24
52
82
26
34
14

Fig. 3

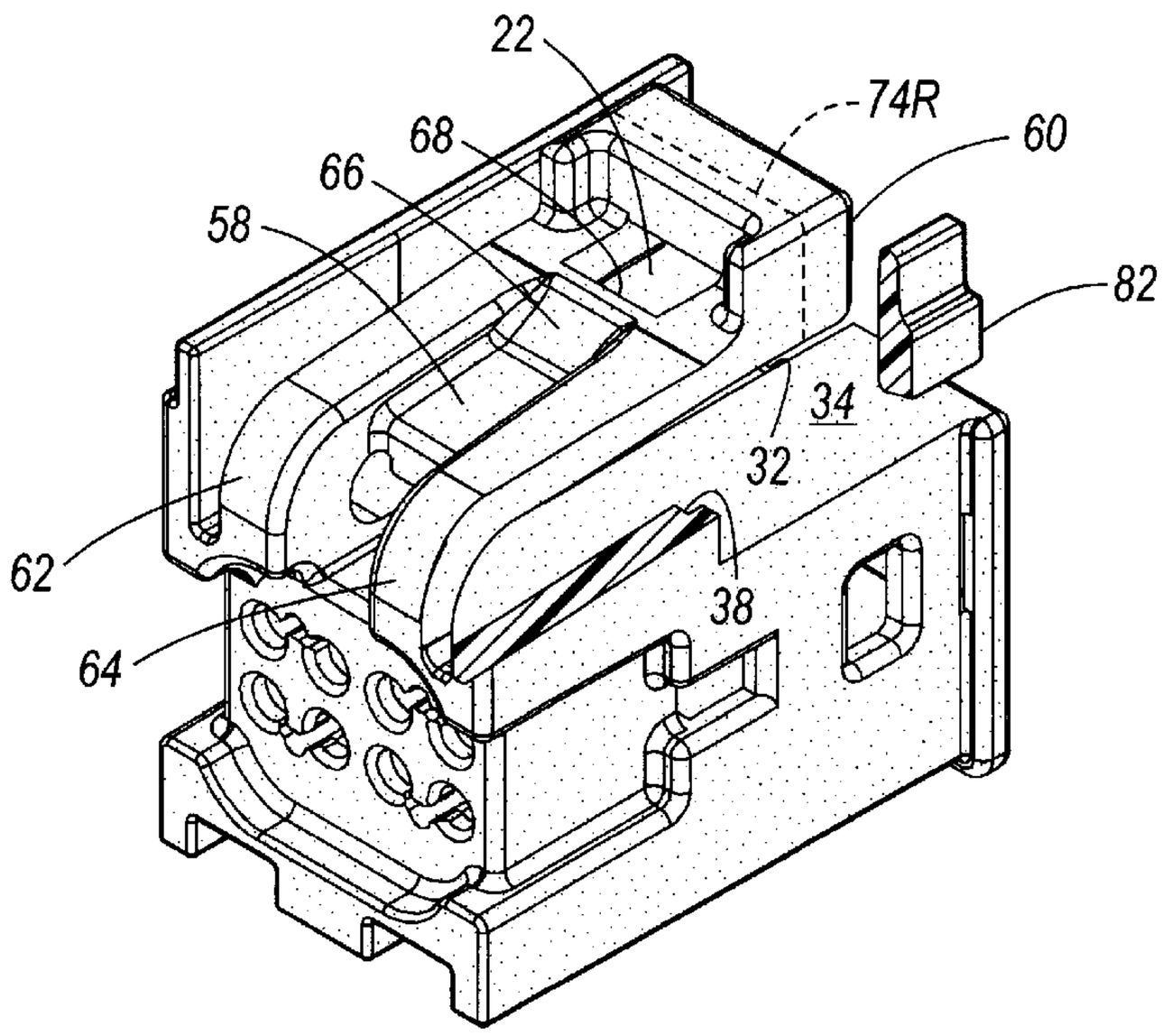

22
74R
68
60
66
58
82
34
32
62
38
64

Fig. 4

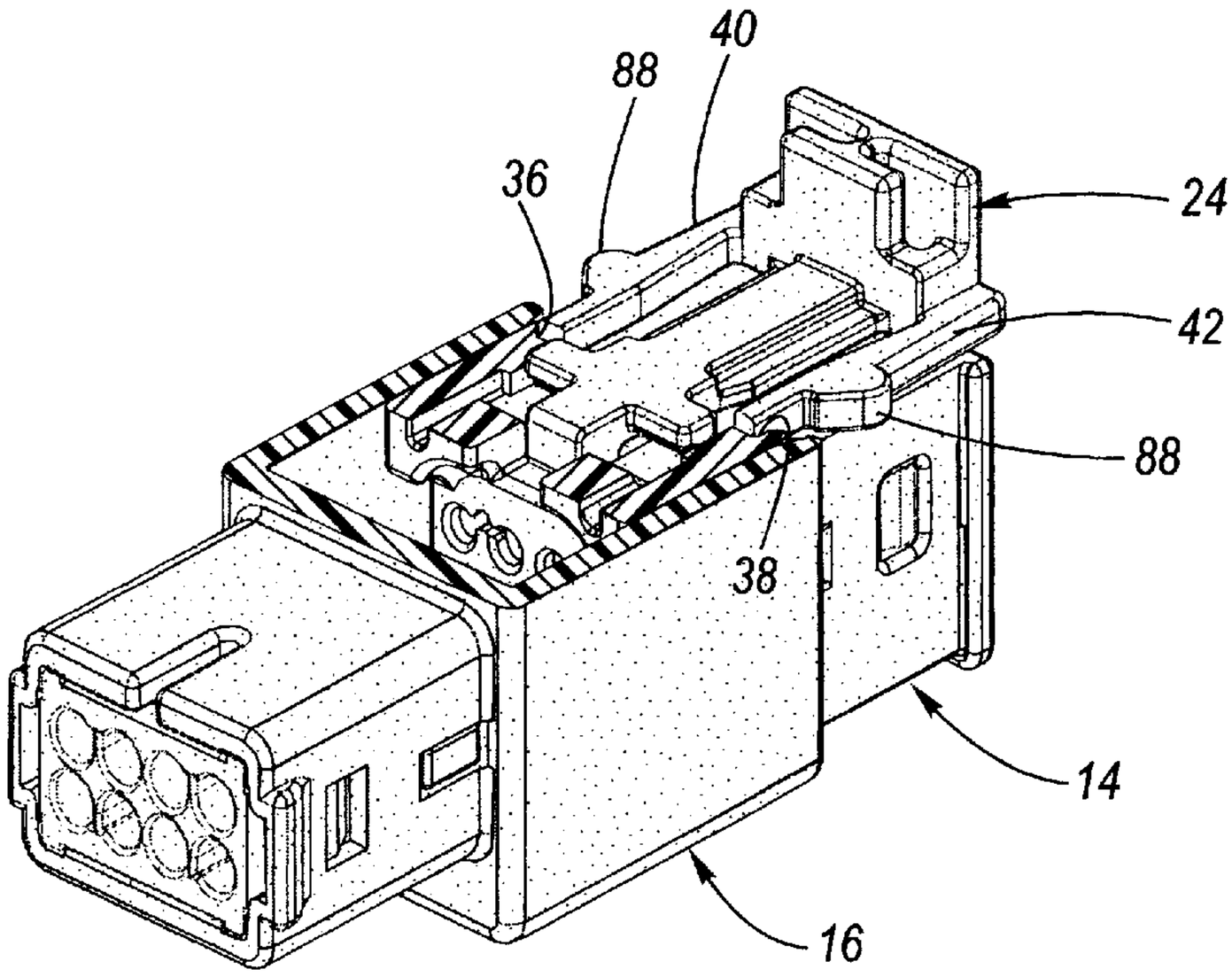

40
88
36
24
42
88
38
14
16

Fig. 5

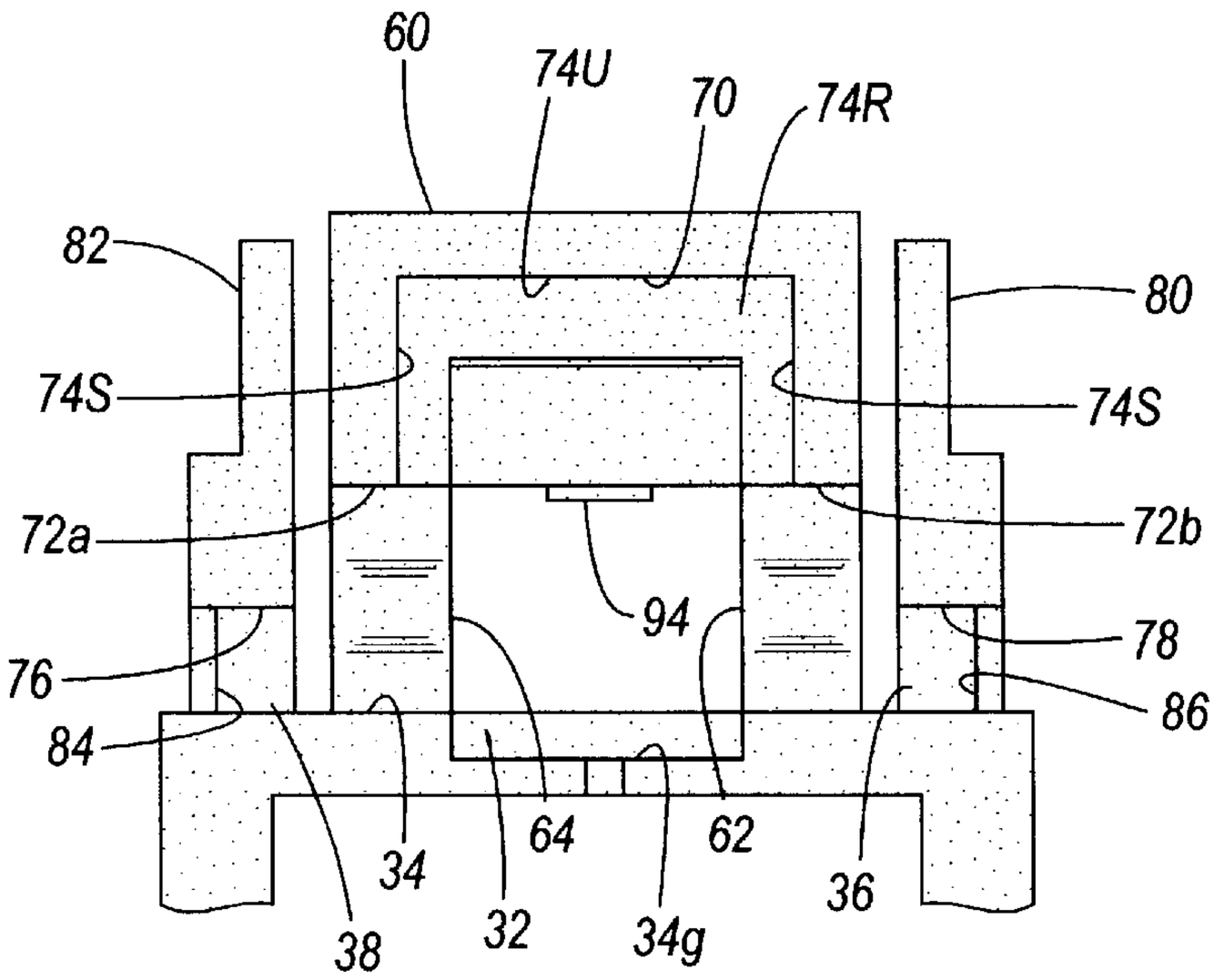

60
74U
70
74R
82
80
74S
74S
72a
72b
94
76
78
86
84
34
64
62
38
32
34g
36

Fig. 6

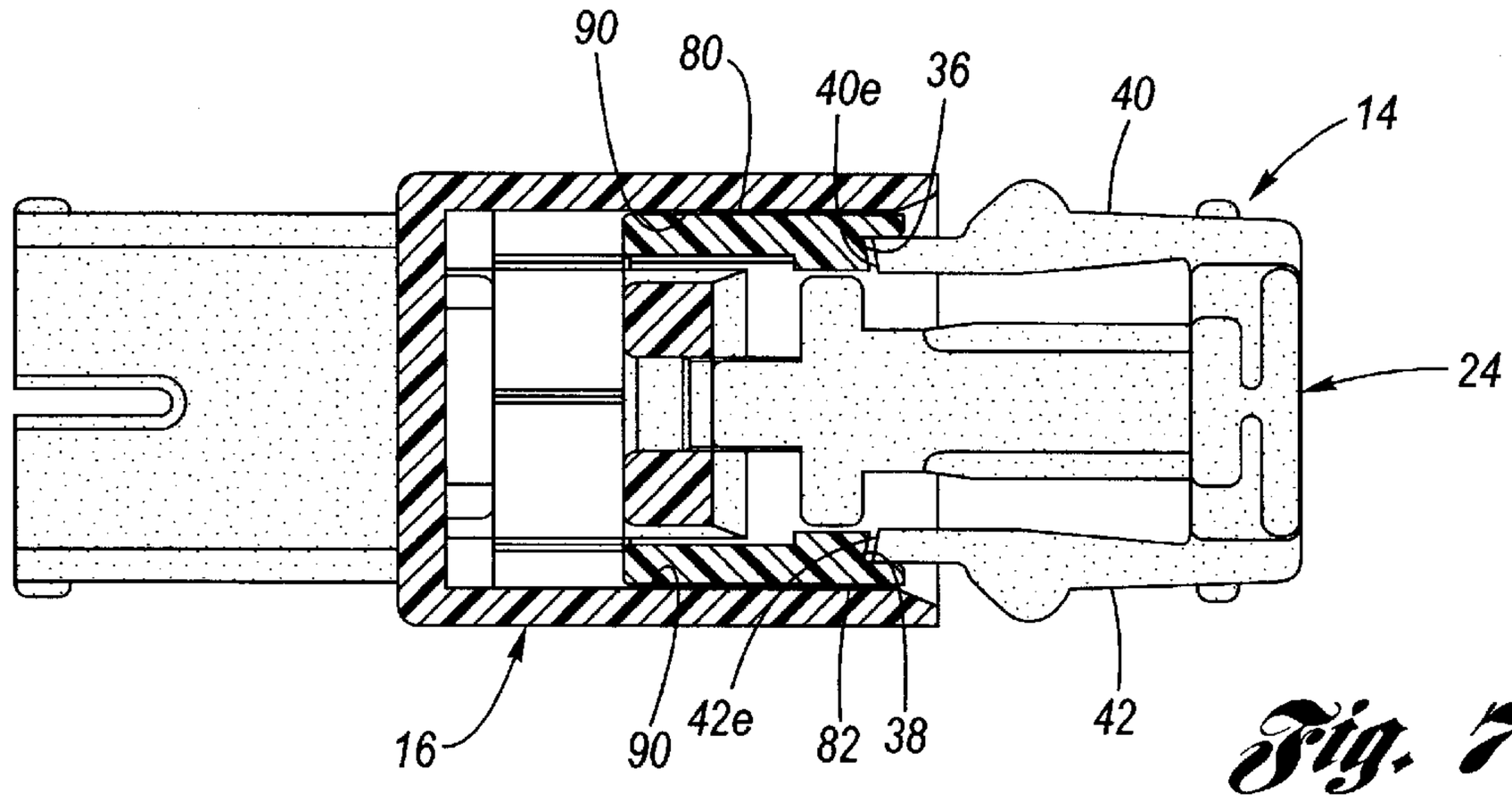


Fig. 7

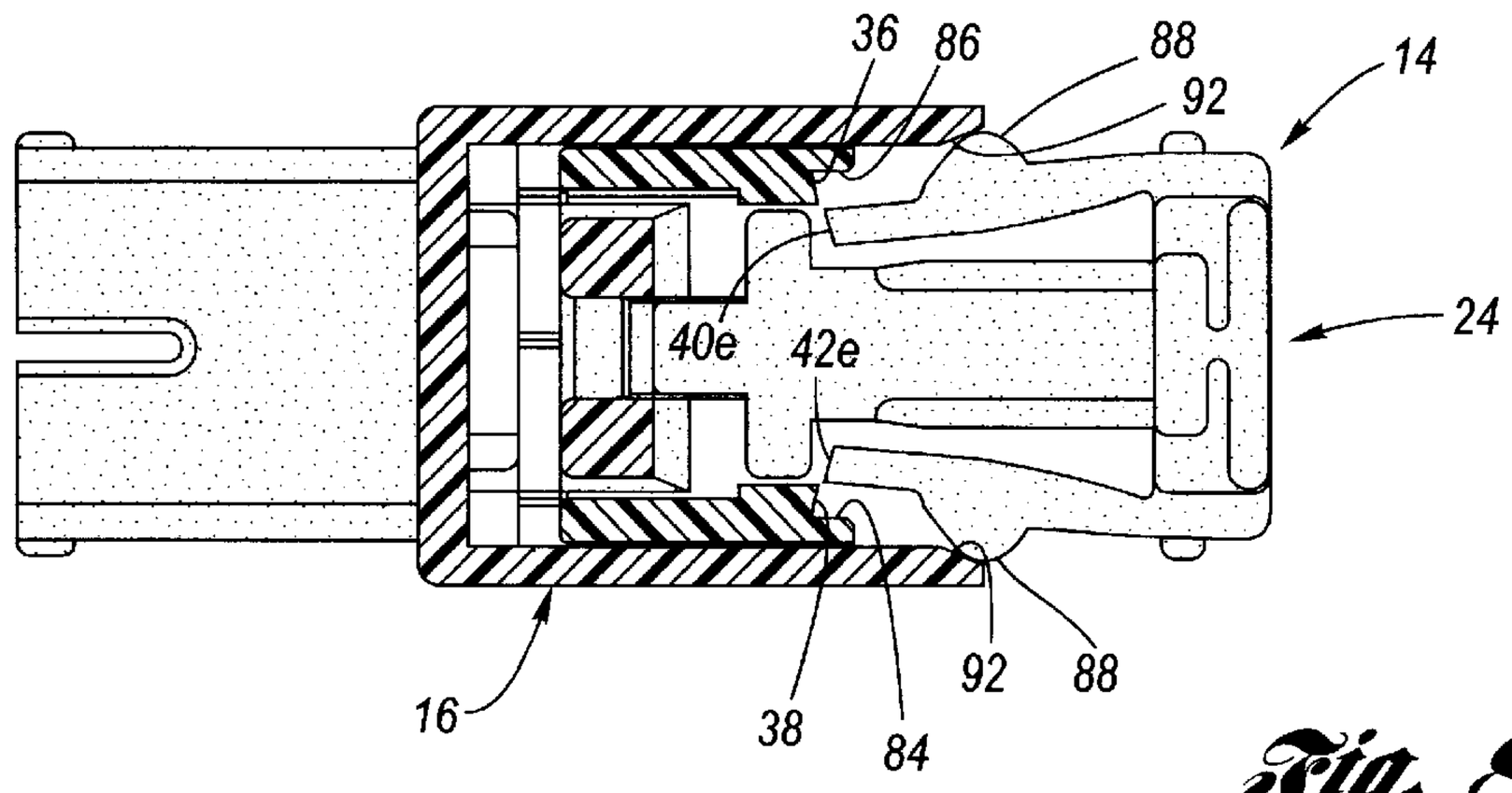


Fig. 8

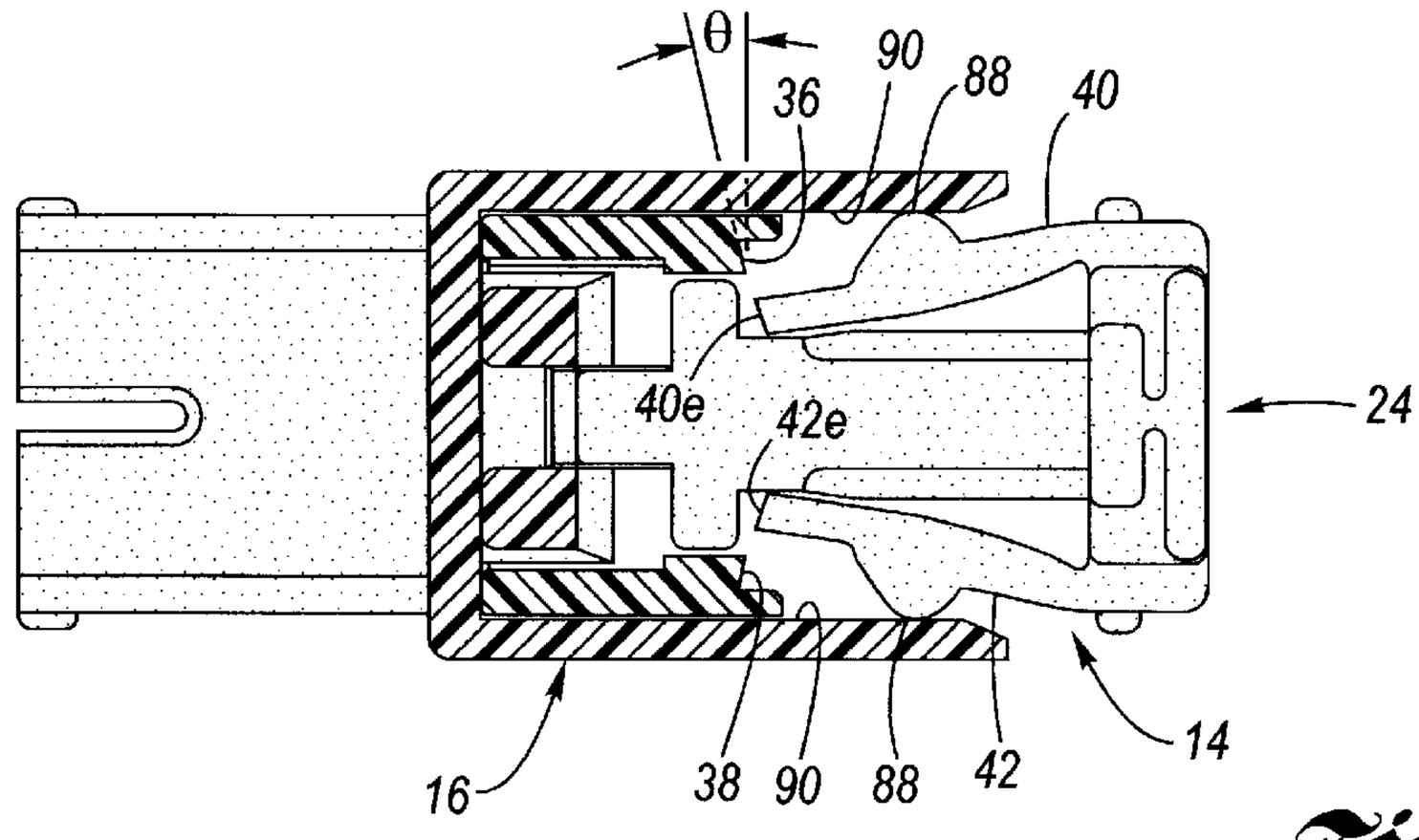


Fig. 9

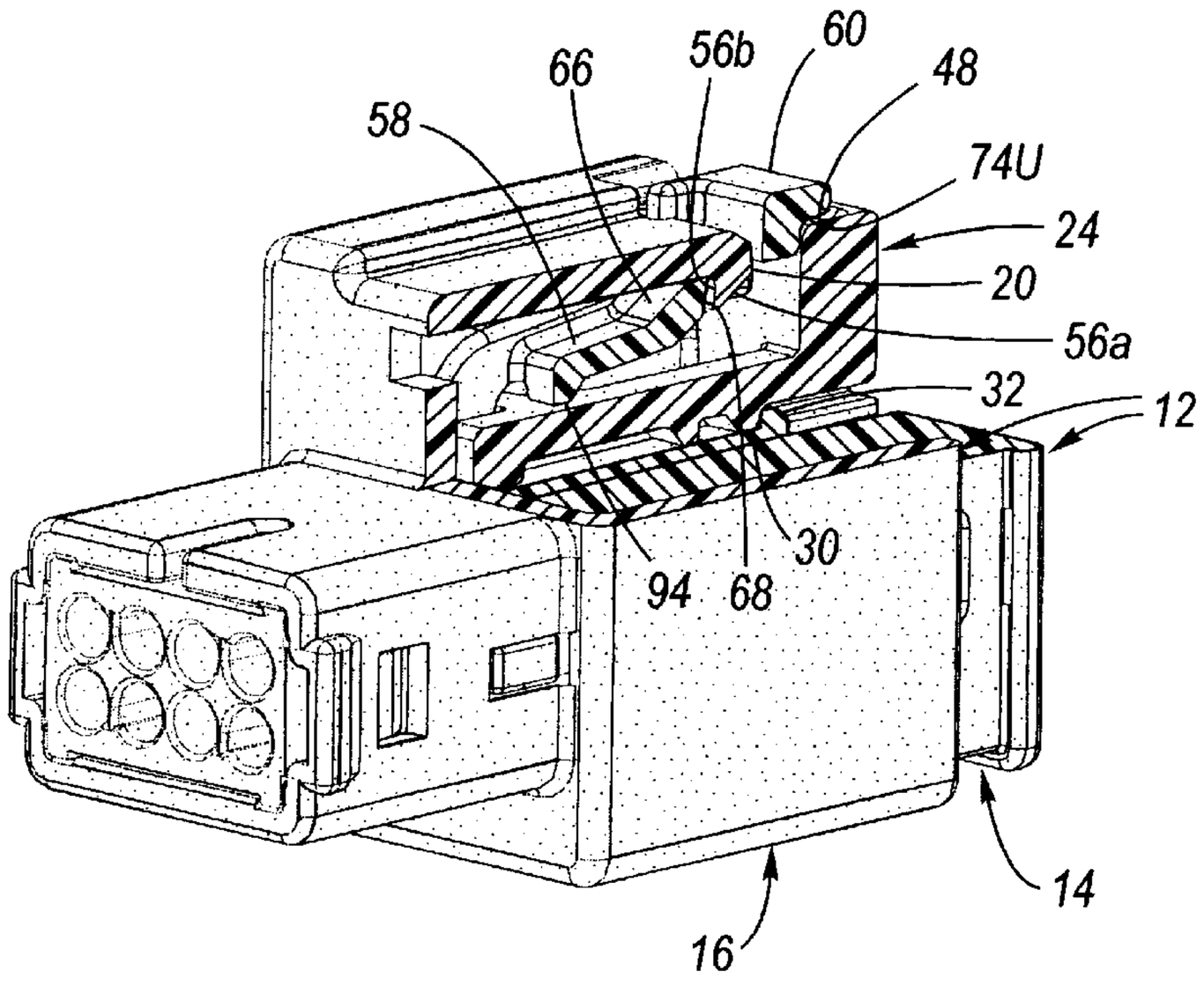

58
66
56b
60
48
74U
24
20
56a
32
12
94
68
30
14
16

Fig. 10

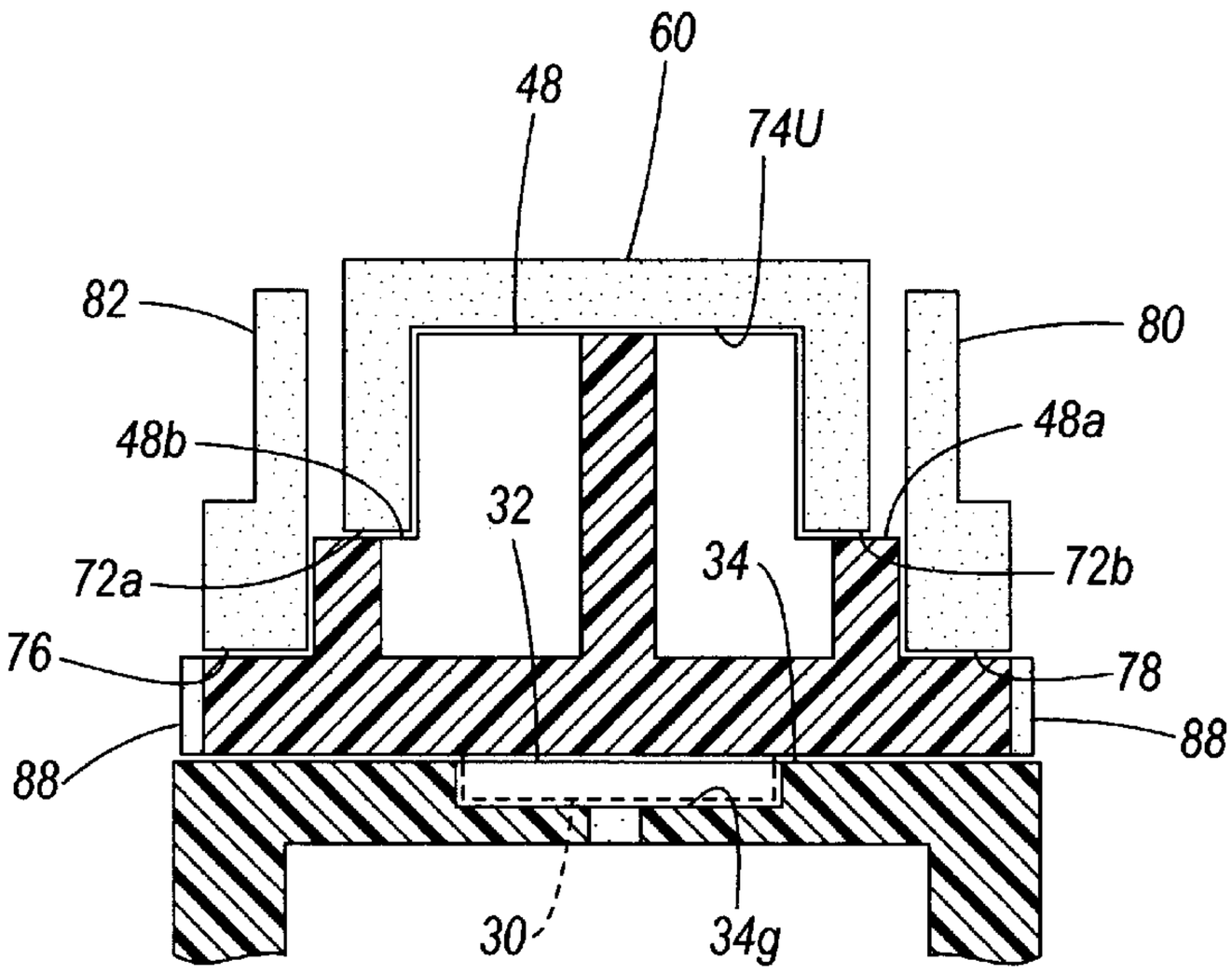

60
48
74U
82
80
48b
48a
32
72a
34
72b
76
78
88
88
30
34g

Fig. 11

CONNECTOR POSITION ASSURANCE DEVICE

TECHNICAL FIELD

The present invention relates to conductor connectors, and more particularly to connector position assurance devices therefor.

BACKGROUND OF THE INVENTION

Electrical, fiber optic and other types of connections are effected utilizing two mutually interfitting connectors, commonly in the form of mating male and female connectors. Each interfitting connector caries electrical, fiber optic or other conductors which are mutually situated and mutually configured so as to provide a connection therebetween when the interfitting connectors are mated to each other.

One problem that can arise is that the two intermitting connectors may not be fully mated, or may have been mated but have subsequently become dislodged from one another due to, for example, vibration. It is common practice, therefore, in the connector art to provide a connector position assurance (CPA) device which assures mating of the interfitting connectors.

An example of a pair of interfitting connectors having a CPA device is described in U.S. Pat. No. 6,210,186 B1. This example utilizes a pair of connectors, one connector having a CPA device and a slide assist cover which is connected with a U-shaped slide having partly angled slots, and the other connector having tabs. The two connectors are mated by first arranging the connectors so that the tabs enter the slots, and then sliding the slide assist cover to cause the slots to mate the connectors. The CPA device is then actuated. Interestingly, it is possible to move the slide assist cover and then actuate the CPA device even though the mating connector is absent.

While the aforementioned example works very well and is the epitome of slide assist type connectors, what remains needed in the connector art is a CPA device which is entirely located on one connector, yet is actuable only upon the connectors having actually mated.

SUMMARY OF THE INVENTION

The present invention is a CPA device located on one connector of a pair of interfitting connectors, wherein the CPA device is actuable only in the event that the two connectors are actually mated.

The CPA device according to the present invention is entirely located at one connector (the CPA connector). The CPA connector is provided with a CPA channel into which a CPA slide is located. The CPA slide interacts with the CPA channel snappingly at two sliding positions of the CPA slide relative to the channel: a prestaged position and a staged position.

A CPA actuation lock is provided, wherein the CPA channel includes a pair of channel abutments, and the CPA slide has a pair of resilient arms, the ends of which abut, respectively, the channel abutments when the CPA slide is at the prestaged position. The abutting interaction of the channel abutments with respect to the resilient arms prevents the CPA slide from being snappingly slid to the staged position.

As the CPA connector is mated to the other connector (the non-CPA connector), the non-CPA connector pushes upon the resilient arms so as to resiliently bend them out of abutment with respect to the channel abutments, thereby releasing the CPA actuation lock and allowing the CPA slide to be snappingly slid to the staged position.

Operationally, the CPA and non-CPA connectors share a clasp mechanism. Upon mating of the interfitting connectors, the CPA slide is free to be snappingly slid to the staged position, whereat the CPA slide interferes with the clasp mechanism so as to prevent unintentional release of the clasp mechanism.

Accordingly, it is an object of the present invention to provide a CPA device located on one connector of a pair of interfitting connectors, wherein the CPA device is actuable only in the event that the two connectors are actually mated.

This and additional objects, features and advantages of the present invention will become clearer from the following specification of a preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of two interfitting connectors, one of which is equipped with the CPA device according to the present invention.

FIG. **2** is a partly sectional perspective view of the two interfitting connectors of FIG. **1**, shown mated, and wherein the CPA slide is at the prestaged position.

FIG. **3** is a perspective view of the CPA connector of the two interfitting connectors and the CPA slide therefor.

FIG. **4** is a partly sectional perspective view of the CPA connector of FIG. **3**.

FIG. **5** is a partly sectional perspective view of the two interfitting connectors, wherein the CPA slide is at the prestaged position.

FIG. **6** is a broken-away front end view of the CPA connector.

FIG. **7** is a partly sectional top view of the two interfitting connectors, shown at the position depicted at FIG. **5**, wherein the CPA actuation lock is active.

FIG. **8** is a partly sectional top view of the two interfitting connectors, shown whereat the CPA actual lock has released.

FIG. **9** is a partly sectional top view of the two interfitting connectors, shown fully mated.

FIG. **10** is a partly sectional perspective view of the two interfitting connectors, shown mated and with the CPA slide at the staged position.

FIG. **11** is a view of the CPA connector similar to that of FIG. **6**, wherein the CPA slide is shown at its staged position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the Drawing, FIGS. **1** through **11** depict an example of a CPA device **10** according to the present invention. In this regard, FIG. **1** depicts an exemplar environment of use of the CPA device **10** with respect to two interfitting connectors **12**. One of the connectors is a CPA connector **14**, in that the CPA device **10** is located thereat. The other connector is a non-CPA connector **16**, in that none of the CPA device is located thereat. The interfitting connectors **12** may be any form of connectors, as for example those used in the electrical arts to connect wires or in the fiber optic arts to connect fiber optic fibers.

As shown at FIG. **2**, the exemplified interfitting connectors **12**, are mutually configured so that the CPA connector **14** is matingly received into the non-CPA connector **16**. The two exemplified interfitting connectors **12** are held in a mated state by a clasp mechanism **18**, having, for example, the following clasp elements: a boss **20** of the non-CPA connector **16** being received into a mating slot **22** formed in a resiliently mounted land of the CPA connector **14**. In this

exemplification, the CPA device **10** serves to retain the boss **20** in the mating slot **22**, and is operable to provide this feature once the interfitting connectors **12** are mated.

FIG. **3** shows the aforementioned CPA device **10**, which includes a CPA slide **24** and a CPA channel **26** formed in the body of the CPA connector **14**. The CPA slide **24** is slidably located in the CPA channel **26**, as generally exemplified at FIG. **2**, wherein a bottom surface of the CPA slide has first and second lips **28**, **30** which must be snappingly moved over a rib **32** formed at a groove **34***g* of the floor **34** of the CPA channel. Accordingly, the CPA slide **24** is retained in the CPA channel **26** provided the first lip **28** has passed over the rib **32**. With the rib **32** located between the first and second lips **28**, **30**, the CPA slide is at its prestaged position with respect to the CPA connector **14**, as shown at FIG. **2**.

A CPA actuation lock is in the form of the CPA channel **26** having a pair of channel abutments **36**, **38** (see FIGS. **4**, **5** and **6**), and the CPA slide having a pair of resilient arms **40**, **42** (see FIGS. **3** and **7**), wherein the arm ends **40***e*, **42***e* of the resilient arms abut, respectively, the channel abutments **36**, **38** when the CPA slide is at the prestaged position (see FIG. **5**). The abutting interaction of the channel abutments **36**, **38** with respect to the arm ends **40***e*, **42***e* prevents the CPA slide **24** from being snappingly slid in the direction of the second lip **30** over the rib **32** to its staged position, as shown at FIG. **10**. To enhance the aforementioned abutting function of the CPA actuation lock, the ends **40***e*, **42***e* and the channel abutments **36**, **38** are acutely inclined relative to each other, the inclination angle θ, preferably of about 5 degrees, being such as to tend to inhibit the resilient arms from flexing inwardly toward each other (see FIG. **9**).

Returning to the CPA slide **24** as shown best at FIG. **3**, the CPA slide further has a head **44** which includes a rear wall **46**, a primary CPA abutment **48** and a pair of secondary CPA abutments **48***a*, **48***b* on either side thereof. The resilient arms **40**, **42** are attached to the head **44**. The CPA slide further features a central body **50** which is connected with the head **44**, and terminates forwardly of the resilient arms in the form of a post **52** and a pair of cross-arms **54**.

Returning now to the interfitting connectors **12**, the boss **20** of the non-CPA connector **16** has a leading edge **56***a* which is inclined and has a following edge **56***b* which is perpendicular (see FIG. **10**). The mating slot **22** of the CPA connector is formed in a (previously mentioned) land **58** which is resiliently connected to the CPA connector adjacent the rear end of the floor **34**. The land **58** terminates in a header **60**. The preferred resilient connection of the land **58** (and the header **60**) is in the form of two mutually spaced apart curved legs **62**, **64** which connect to the land on either side thereof. On the land **58** is an inclined ramp **66** which adjoins the mating slot **22** and terminates at a slot edge **68**. Accordingly, as the CPA and non-CPA connectors **14**, **16** are mated, the leading edge **56***a* of the boss **20** rides up the inclined ramp **66** (creating a resilient compression at the curved legs **62**, **64**) and then snappingly enters the mating slot **22** as the header springs upwardly when the boss falls off the inclined ramp and into the mating slot. Now, the interfitting connectors **12** are held in the mated state by an interfering abutment of the following edge **56***b* of the boss **20** against the slot edge **68** of the mating slot **22**. To release the mating, the header **60** must be depressed so that the boss clears the slot edge of the inclined ramp. The CPA device **10** selectively presents this from happening by the CPA slide **24** being slid to its staged position whereat the CPA slide prevents the header from being depressed.

Referring particularly to FIG. **6**, the header **60** has a primary slide seat **70** into which the primary CPA abutment **48** is receivable and secondary slide seats **72***a*, **72***b* on either side of the primary slide seat which receives the secondary CPA abutments **48***a*, **48***b* (see FIG. **11**). The primary slide seat **70** is in the form of an open-bottom recess demarcated by a U-shaped recess wall **74**R an upper recess wall **74**U and side recess walls **74**S.

Now referring to FIGS. **3** and **6**, it will be noted that the CPA channel **26** includes guide slots **76**, **78** formed, respectively, in siderails **80**, **82**. The guide slots **76**, **78** terminate, respectively, at the channel abutments **36**, **38**. A guide tab **84**, **86** is provided at each of the guide slots **76**, **78**. As indicated additionally by FIG. **5**, the CPA channel **26** is structured so that the CPA slide **24** slides along the floor **34** with the first and second lips **28**, **30** being situated in the groove **34***g*, and so that the resilient arms **40**, **42** are situated in the guide slots **76**, **78**, wherein nibs **88** of the resilient arms protrude.

Referring now in particular to FIGS. **7** through **11**, operation will be discussed.

At FIG. **7**, the CPA connector **14** has been partly inserted into a mating port of the non-CPA connector **16**, wherein port sidewalls **90** of the non-CPA connector abut the siderails **80**, **82**. The CPA slide is at the prestaged position.

At FIG. **8**, the CPA connector is further inserted into the mating port, during which the nibs **88** come into abutment with an entry bevel **92** of the port sidewalls **90**. Still further insertion results in the nibs **88** being forced inwardly by the sidewalls, which is possible because of flexing by the resilient arms **40**, **42**. The flexing of the resilient arms **40**, **42** results, in turn, with the arms ends **40***e*, **42***e* being moved out of an interfering abutment with the channel abutments **36**, **38**. The CPA slide continues to remain at the prestaged position.

At FIG. **9**, the CPA connector **14** is fully mated with the non-CPA connector, and the resilient arms **40**, **42** are flexed inwardly so as to be well clear of channel abutments **36**, **38**. The CPA slide still remains at the prestaged position.

Simultaneously during the movements indicated at FIGS. **7** through **9**, the boss **20** has traveled along the inclined ramp **66**, causing the header **60** to be resiliently flexed downwardly (toward the floor **34**) until the boss has cleared the slot edge **68**, whereupon the header springs upwardly and traps the boss in the slot **22**, as depicted at FIG. **2**.

In order to prevent flexing of the header **60**, which effectively causes the two interfitting connectors **12** to be assuredly locked together in the mating position, the CPA slide **24** is slid toward the non-CPA connector **16** to the staged position, whereupon the second lip **30** has snapped over the rib **32**, as shown at FIG. **10**. Now, at the staged position, the primary CPA abutment **48** is received into the primary slide seat **70** of the header such that the header cannot be flexed toward the floor because of the interfering abutment of the primary CPA abutment with respect to the upper recess wall **74**U. Additionally, at the staged position of the CPA slide, the secondary CPA abutments **48***a*, **48***b* interferingly abut, respectively, the secondary slide seats **72***a*, **72***b* which also serve to prevent flexing of the header toward the floor (see FIG. **11**, wherein parts spacing is shown emphasized for clarity).

As the CPA slide **24** achieves the staged position, the primary CPA abutment **48** applies a force on the header **60** tending to flex it upwardly (away from the floor **34**) as the second lip **30** snaps over the rib **32** (as also happened when the first lip **28** passed over the rib **32**). In this regard, the header **60** is held from moving upwardly to any substantial amount by the boss **20**, which also serves to assist preven-

tion of the second lip **30** from backing out over the rib **32**. Indeed, intentional prying is necessary to extract the CPA slide **24** from the staged position. A lug **94** (see FIG. **10**) is located on the land **58** adjacent the curved legs **62**, **64** which serves as a hold-down for the CPA slide **24** at the post **52** thereof. At the staged and prestaged positions of the CPA slide **24**, the ends of the cross-arms **54** guidably abut the siderails **80**, **82** and the post **52** is located guidably between the curved legs **62**, **64**. When the CPA slide **24** achieves the staged position, the cross-arms **54** abut the curved legs **62**, **64**.

It is to be noted that the entire CPA device **10** is located on the CPA connector **14**, and further that the CPA slide is prevented from moving unless the two interfitting connectors **12** are mated. These features provide connector mating position assurance, wherein manufacturing is simplified by the entire CPA device being located on a single one of the connectors.

To those skilled in the art to which this invention appertains, the above described preferred embodiment may be subject to change or modification. Such change or modification can be carried out without departing from the scope of the invention, which is intended to be limited only by the scope of the appended claims.

What is claimed is:

1. In a pair of interfitting first and second connectors selectively held in a mutually mated relationship by a clasp mechanism connected to the first and second connectors, the improvement thereto comprising: a connector position assurance device connected to the first connector, said connector position assurance device comprising:

a slide slidable with respect to the first connector from a prestaged position to a staged position, wherein when said slide is at said prestaged position said clasp mechanism is operable between a clasped position for holding the first and second connectors at the mutually mated relationship and an unclasped position whereat the first and second connectors may enter into and be exited from the mutually mated relationship, and wherein when said slide is at said staged position said clasp mechanism is retained in the clasped position; and

a connector position assurance actuation lock having a locked state and unlocked state, wherein said slide is only slidable to said staged position when said connector position assurance actuation lock is in the unlocked state, and wherein said unlocked state occurs only when the first and second connectors are mutually mated;

wherein said connector position assurance actuation lock comprises:

the first connector having a channel formed therein which defines a pair of acutely angled channel abutments; and

a pair of resilient arms located on said slide, each said arm terminating in an acutely angled arm end;

wherein said slide is slidable in said channel between said prestaged and staged positions; and

wherein said locked state is defined by said acutely angled arm ends abutting said acutely angled channel abutments wherein an inclination angle of the acutely angled arm ends and channel abutments inhibits said pair of resilient arms from flexing inwardly toward each other, and wherein said unlocked state is defined by said resilient arms being resiliently bent out of abutment with said channel abutments by abutment with the second connector when said first and second connectors are mutually mated.

2. The connectors of claim **1**, wherein the clasp mechanism comprises a boss on said second connector being selectively received into a mating slot formed in a land resiliently connected to the first connector, said land being resiliently moved by said boss as said boss enters and exits said mating slot; wherein said connector position assurance device further comprises an abutment connected to said slide; wherein at said staged position said abutment prevents said land from being resiliently moved by said boss.

3. The connectors of claim **2**, wherein said channel further defines a pair of guide slots, each guide slot terminating at a respective said channel abutment; wherein said resilient arms each have a nib formed thereon; and wherein said resilient arms are located in said guides slots such that said nibs protrude therefrom so as to be abutted by said second connector when said first and second connectors are mated, thereby causing said arm ends to be placed out of abutment with said channel abutments.

4. The connectors of claim **3**, wherein said prestaged position is defined by a first snapping interaction between said slide and said first connector, and wherein said staged position is defined by a second snapping interaction between said slide and said first connector.

5. The connectors of claim **4**, wherein said first and second snapping interactions are directed oppositely with respect to said boss relative to said land.

6. The connectors of claim **5**, wherein a header is connected to said land such that said header is constrained to move with said land, said header having a seat formed therein; wherein at said staged position, said abutment of said slide is received in said seat.

7. The connectors of claim **6**, wherein at said staged position said boss biases said a header, and, in turn, said slide by said header, in a direction oppositely in relation to said second snapping interaction.

8. A first connector for being mated to a second connector, said first connector comprising:

a connector body;

a clasp element resliently mounted to said connector body; and

a connector position assurance device comprising:

a slide slidable relative to said connector body from a prestaged position to a staged position, wherein when said slide is at said prestaged position said clasp element is resiliently movable in a predetermined direction and when at said staged position said clasp element is immovable in the predetermined direction; and

a connector position assurance actuation lock having a locked state and unlocked state, wherein said slide is only slidable to said staged position when said connector position assurance actuation lock is in the unlocked state, and wherein said unlocked state occurs only when the first and second connectors are mutually mated;

wherein said prestaged position is defined by a first snapping interaction between said slide and said first connector, and said staged position is defined by a second snapping interaction between said slide and said first connector; and

wherein said first and second snapping interactions are directed oppositely with respect to said predetermined direction.

9. The connector of claim **8**, wherein said connector position assurance actuation lock comprises:

a channel formed in said connector body which defines a pair of channel abutments; and

a pair of resilient arms located on said slide, each said arm terminating in an arm end;

wherein said slide is slidable in said channel between said prestaged and staged positions; and

wherein said locked state is defined by said arm ends abutting said channel abutments, and said unlocked state is defined by said resilient arms being resiliently bent out of abutment with said channel abutments by abutment with the second connector when said first and second connectors are mutually mated.

10. The connector of claim **9**, wherein the clasp element comprises a land resiliently connected to the connector body; wherein said connector position assurance device further comprises an abutment connected to said slide; wherein at said staged position said abutment prevents said land from being resiliently moved in the predetermined direction.

11. The connector of claim **10**, wherein said channel further defines a pair of guide slots, each guide slot terminating at a respective said channel abutment; wherein said resilient arms each have a nib formed thereon; and wherein said resilient arms are located in said guides slots such that said nibs protrude therefrom so as to be abutted by the second connector when said first and second connectors are mated, thereby causing said arm ends to be placed out of abutment with said channel abutments.

12. The connector of claim **11**, wherein a header is connected to said land such that said header is constrained to move with said land, said header having a seat formed therein; wherein at said staged position, said abutment of said slide is received in said seat.

* * * * *